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Non-LTE effects in Al I lines

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Abstract

We present the theoretical analysis of the Al I line formation in the spectra of late-type stars ignoring the assumption of local thermodynamic equilibrium (LTE). The calculations were based on the 39-level aluminum atom model for one-dimensional hydrostatic stellar atmosphere models with the parameters: T eff from 4000 to 9000 K, log g = 0.0-4.5, and metallicity [A] = 0.0;-1.0;-2.0;-3.0;-4.0. The aluminum atom model and the method of calculations were tested by the study of line profiles in the solar spectrum. We refined the oscillator strengths and Van-de--Vaals broadening constants C 6 of the investigated transitions. We conclude that the Al I atom is in the overionization state: the 3p level is underpopulated in the line formation region. This leads to the line weakening, as compared with the LTE results. The overionization effect becomes more pronounced with increasing temperature and decreasing metallicity. We show that the use of various atomic data (ionization cross-sections) for the low levels of Al I does not change the behavior of non-LTE deviations, whereas the value of these deviations varies essentially. For nine selected Al I lines we calculated the grids of theoretical non-LTE corrections (ΔX NLTE = logeε NLTE - log eε LTE) to the Al abundances determinedwith the LTE assumption. The non-LTE corrections are positive and significant for the stars with temperatures T eff > 6000 K. These corrections weakly depend on log g, and increase with declining stellar metallicity.

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Keywords

line: formation, line: profiles, stars: atmospheres